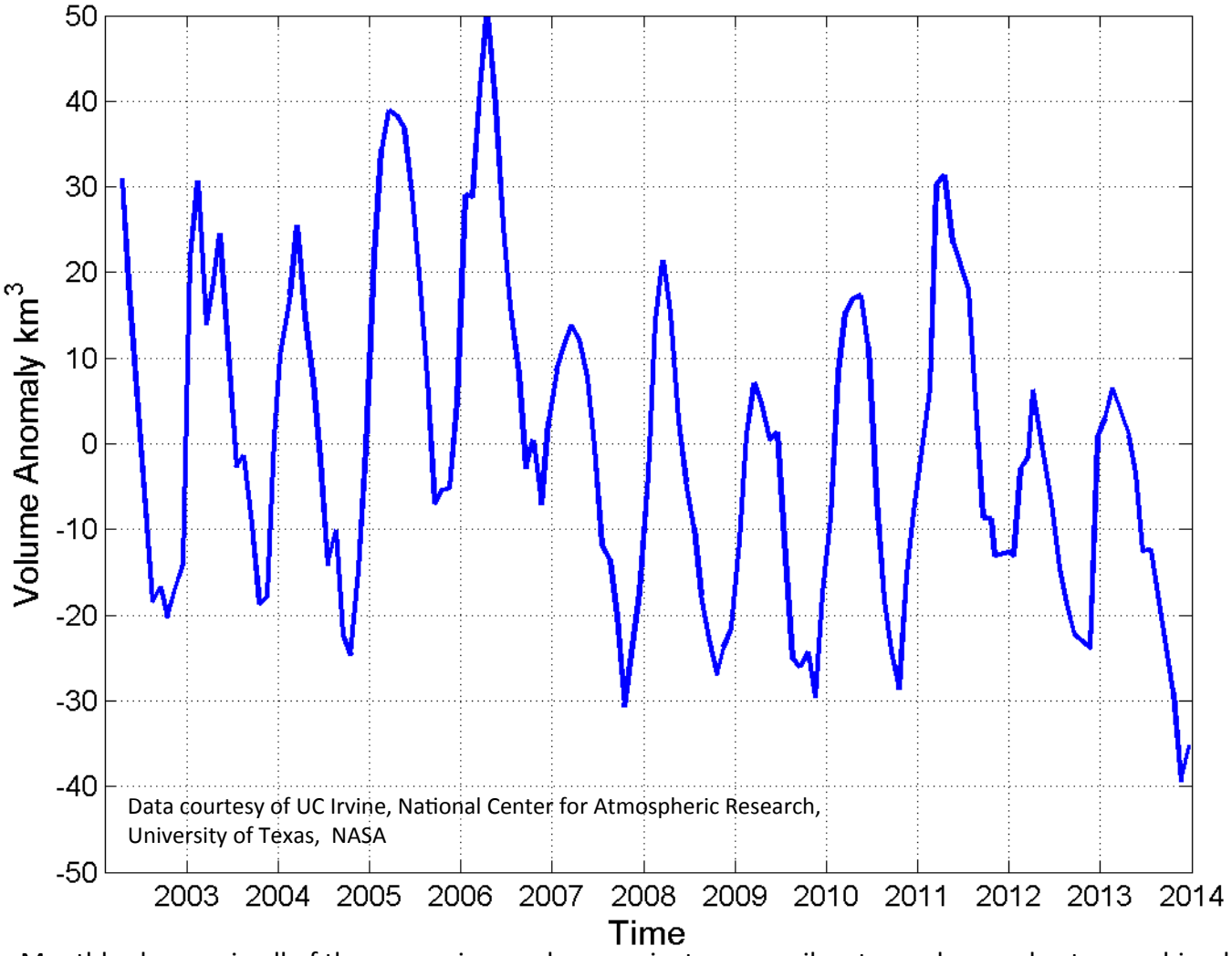
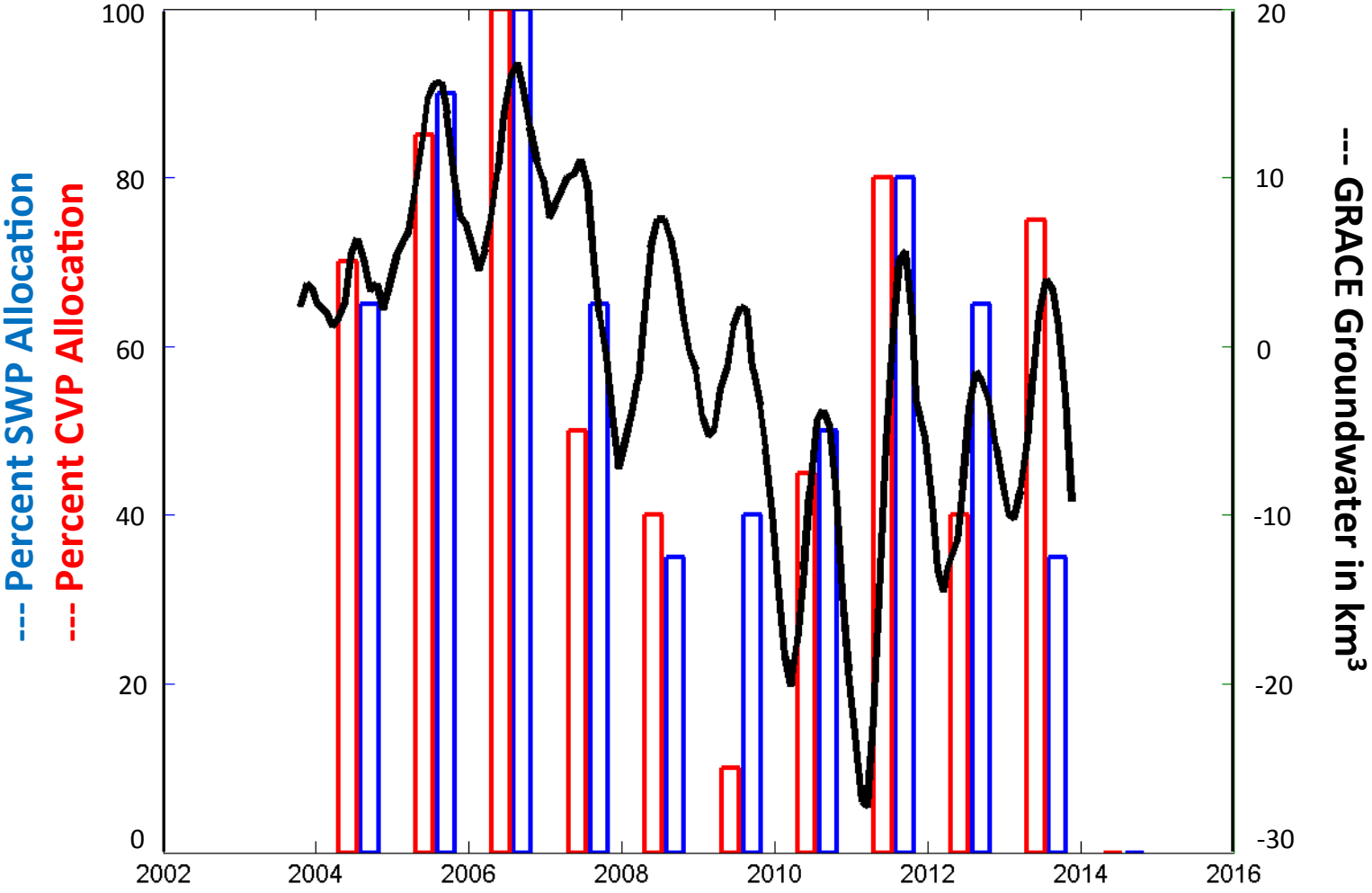
Total Water Storage Changes in the Combined Sacramento-San Joaquin River Basins From the NASA GRACE Satellite Mission for March 2002- December 2013

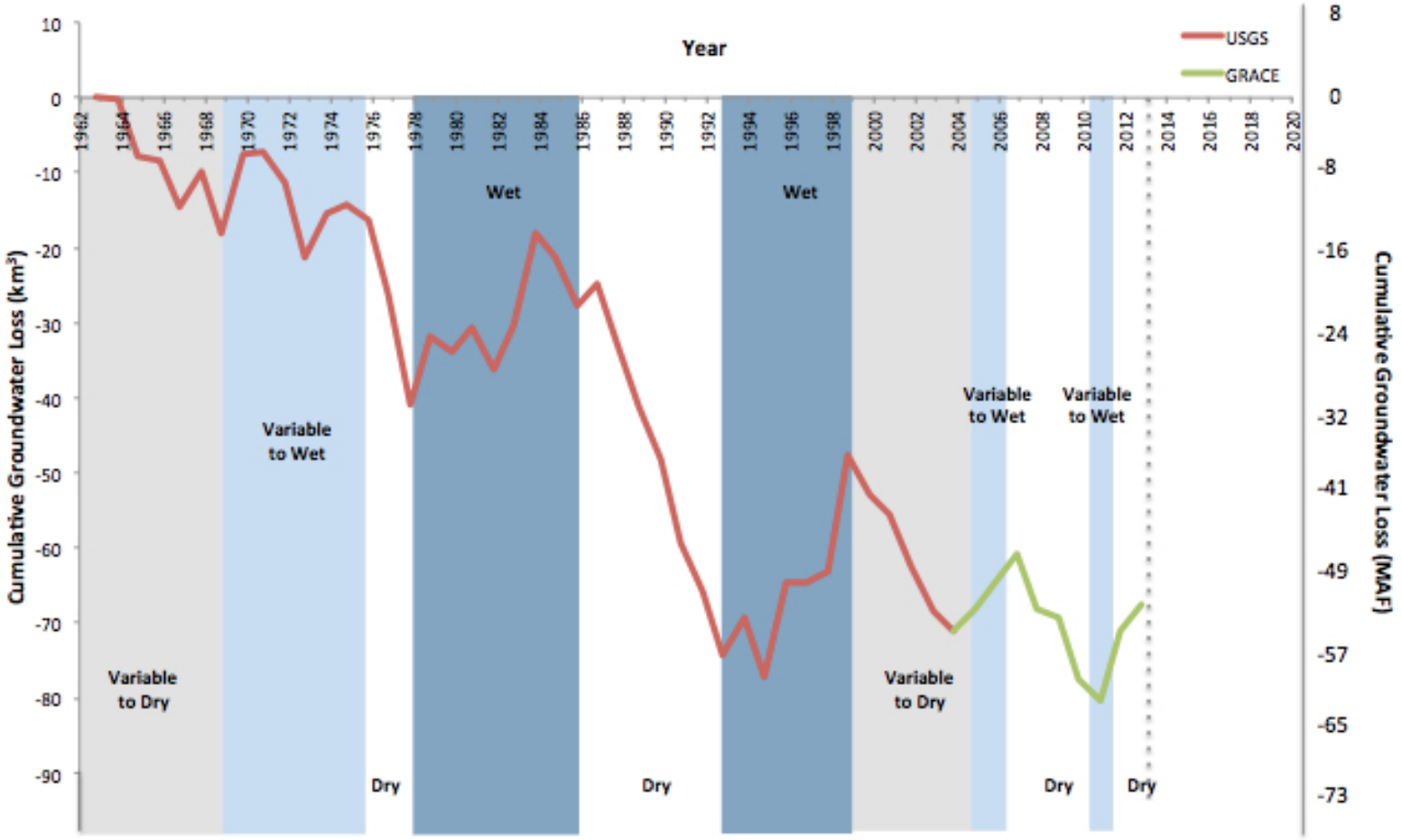


- Monthly changes in all of the snow, river and reservoir storage, soil water and groundwater combined.
- Currently the area is 25 cubic kilometers below its normal low for this time of year (based on the average low for the time period shown

Groundwater depletion and surface water allocations are closely connected



Cumulative Groundwater Depletion in California's Central Valley from USGS and GRACE



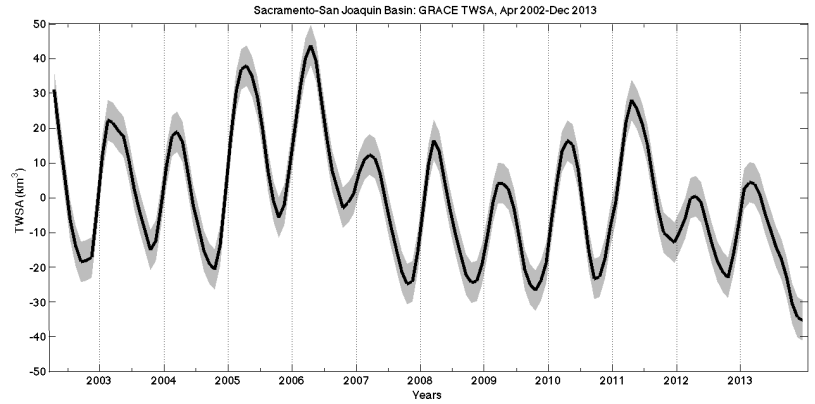
UCCHM, 2014

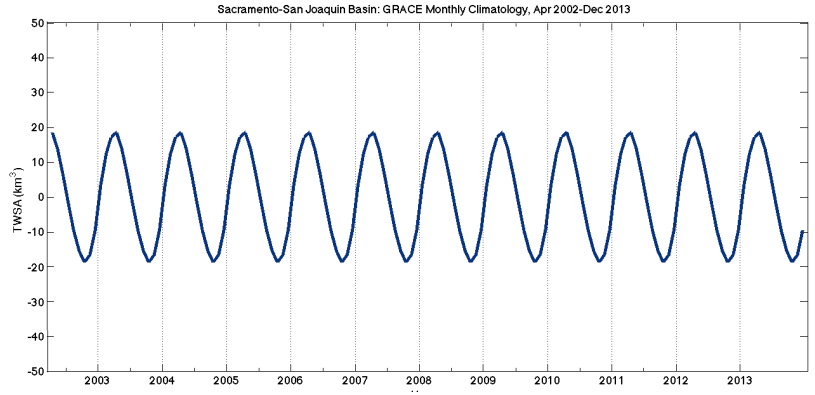
An example of water cycle change from GRACE
Increasing extremes in California

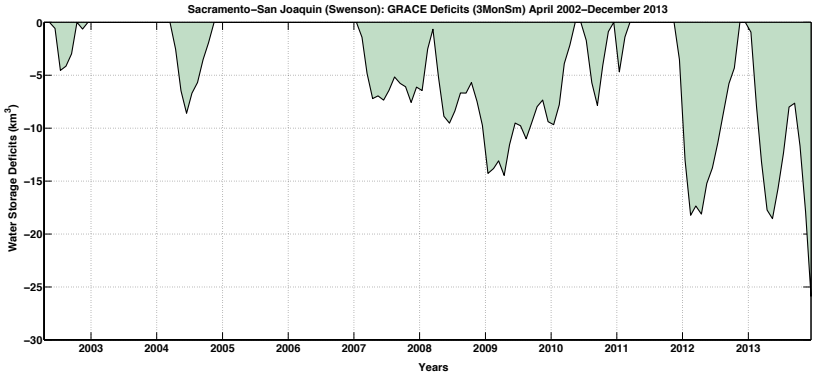
Monthly changes in total water storage

Average changes in total water storage

Negative deviations from average water storage conditons



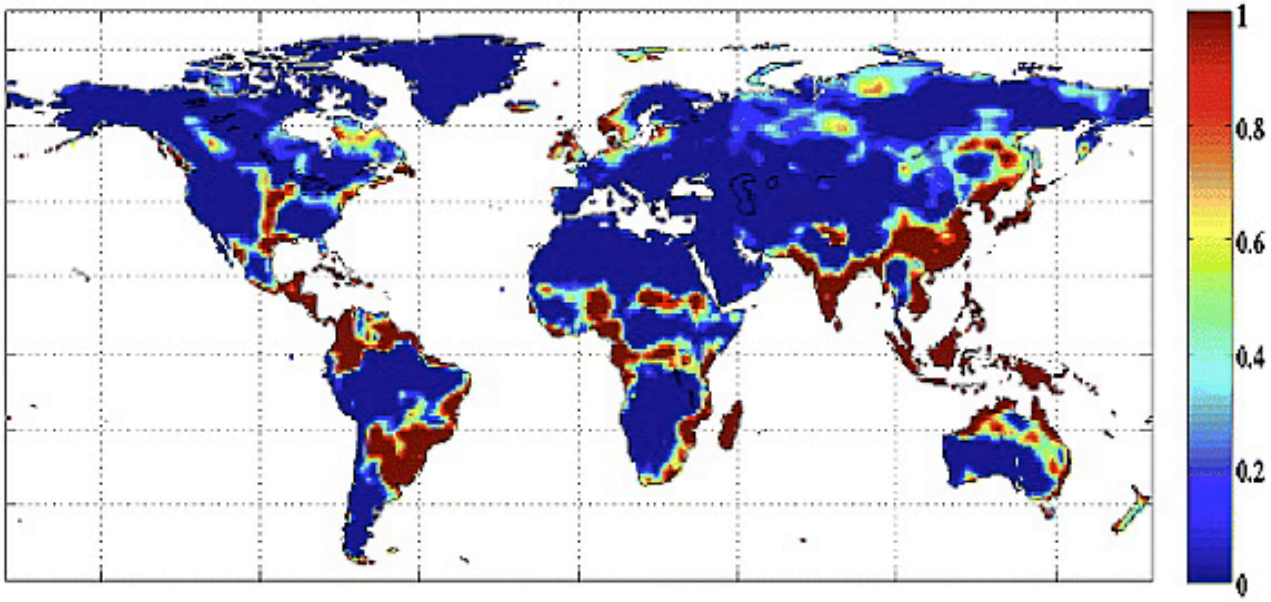




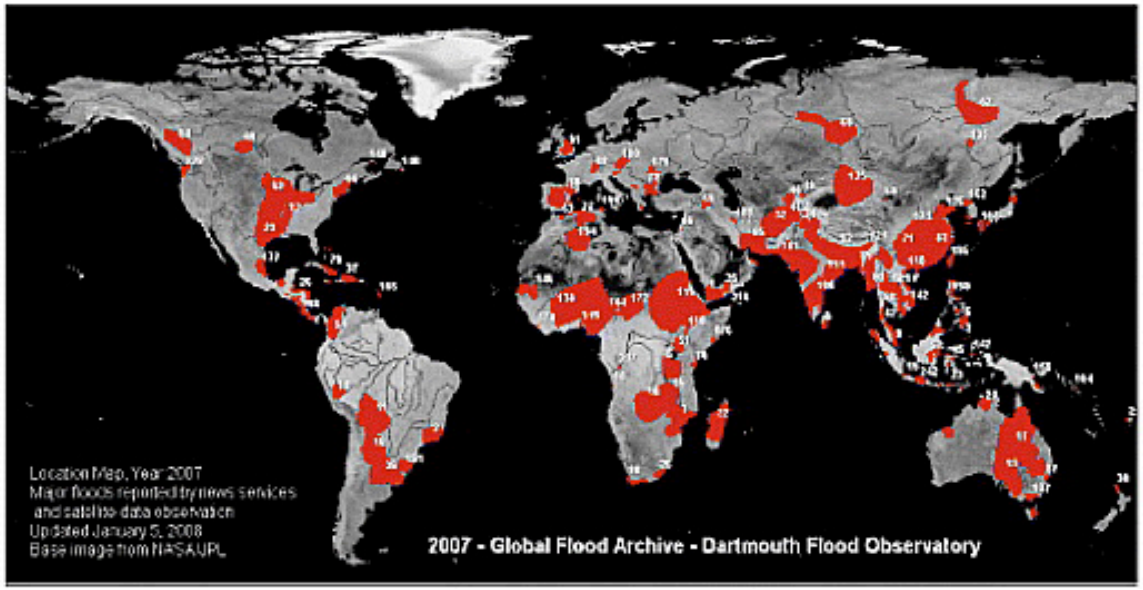
water for california

Thomas et al., 2014

GRACE: Potential for flood prediction



GRACE-based
flood Index maxima
May, 2007

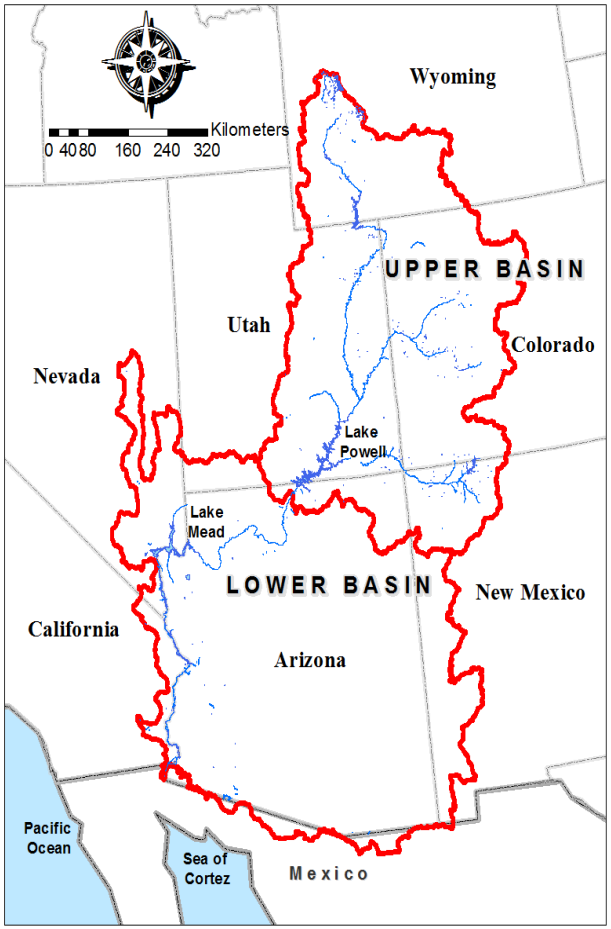


Recorded floods, Dartmouth
Flood Observatory,
May, 2007

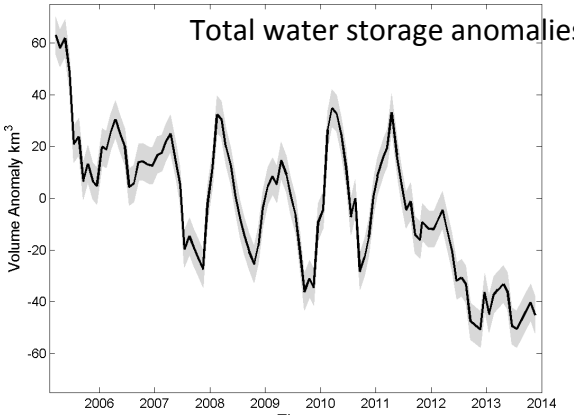
Reager and Famiglietti, 2009

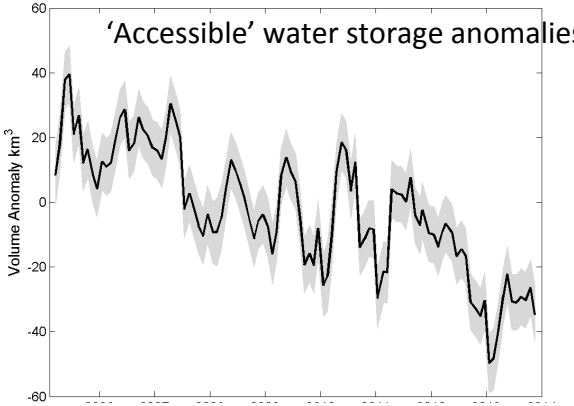
Estimating groundwater storage changes with GRACE

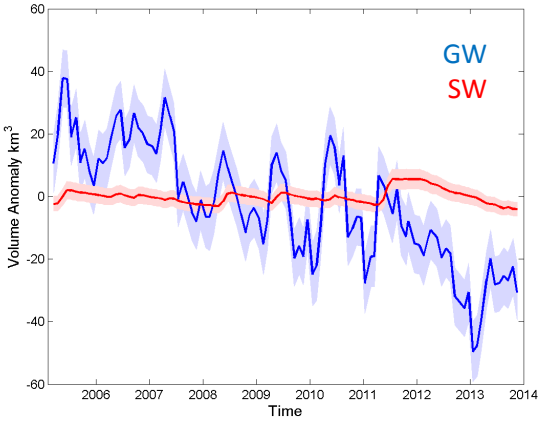
Colorado River Basin



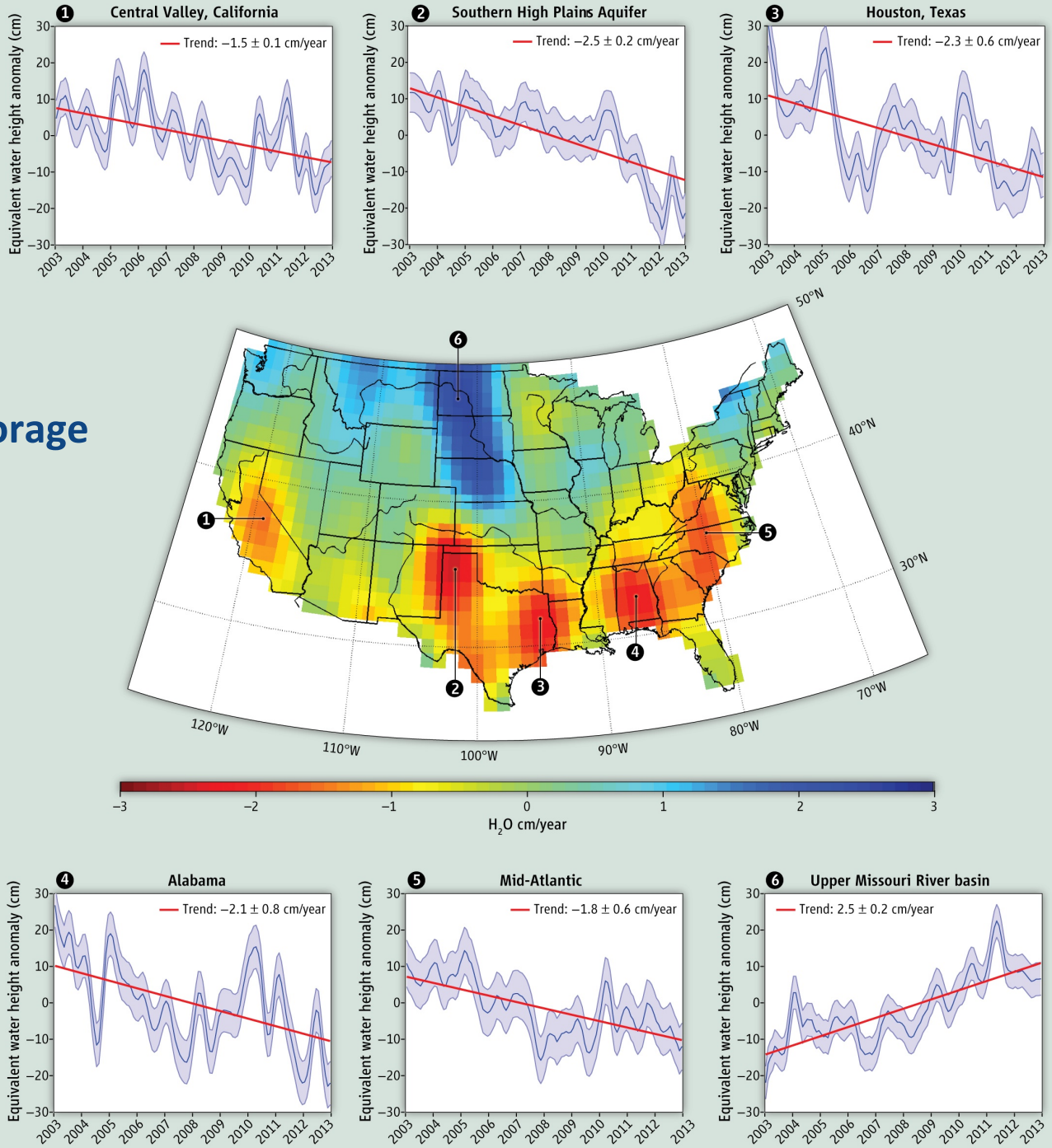
Castle et al., 2014, in prep





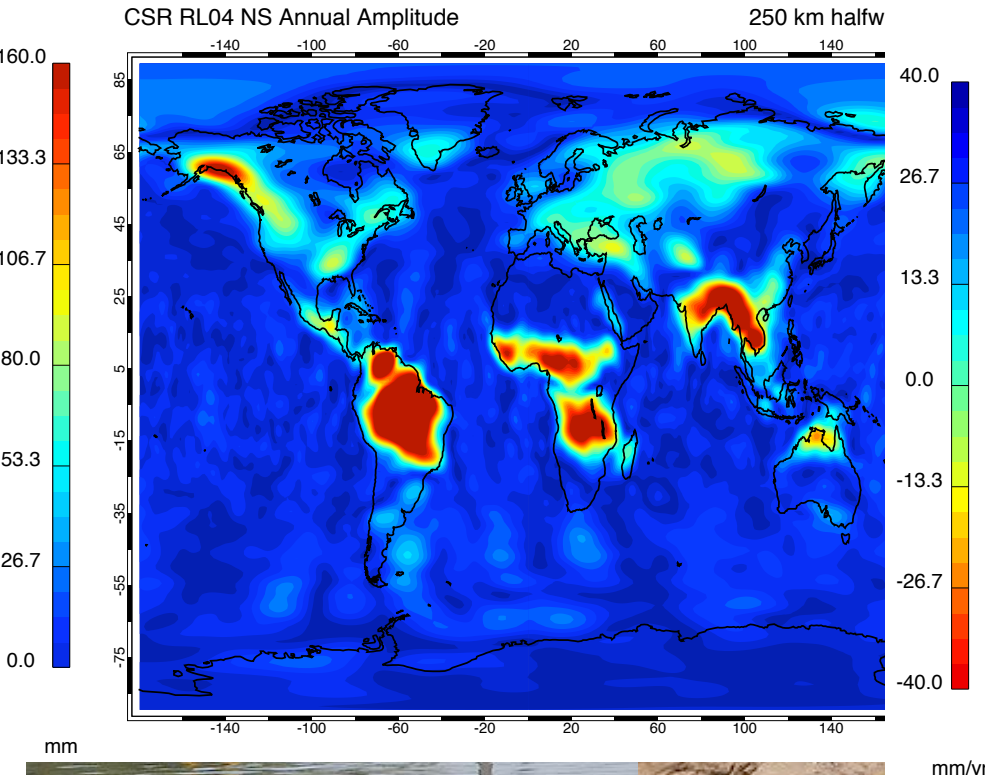


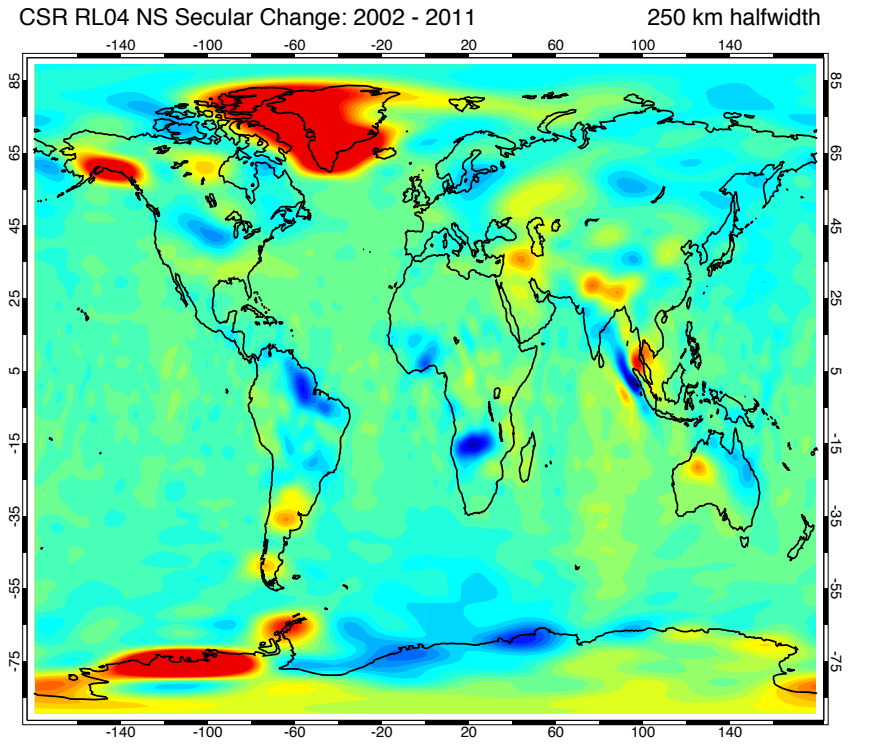
Trends in Freshwater Storage from GRACE, 2003-2012

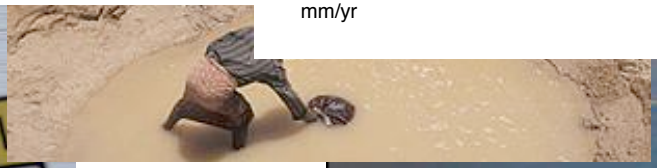


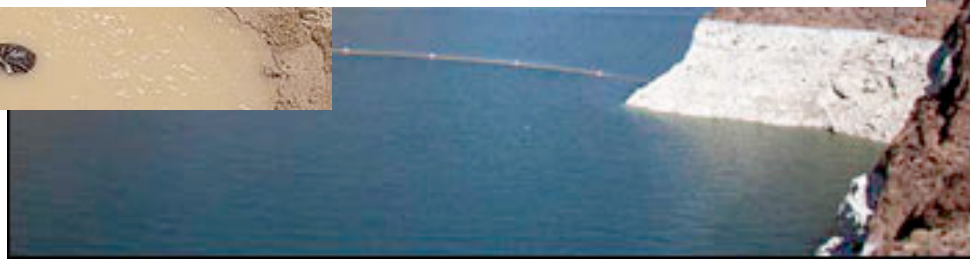
Famiglietti and Rodell, 2013

to the task?









water for california

ucchm.org

Where we are now: Catchment-based for US

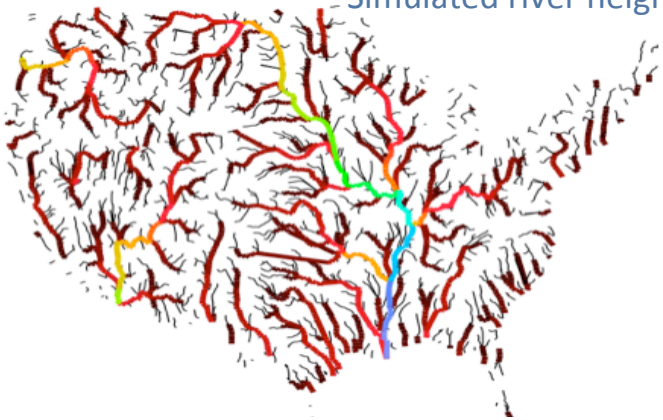
Catchment-based modeling template with explicit river network

Main River Reach

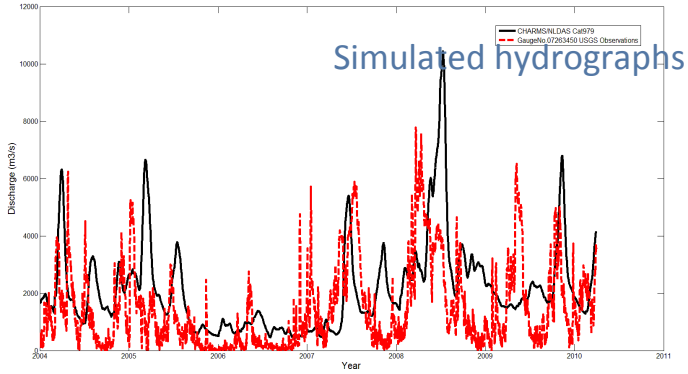
Catchment

Simulated river depth

Simulated river height

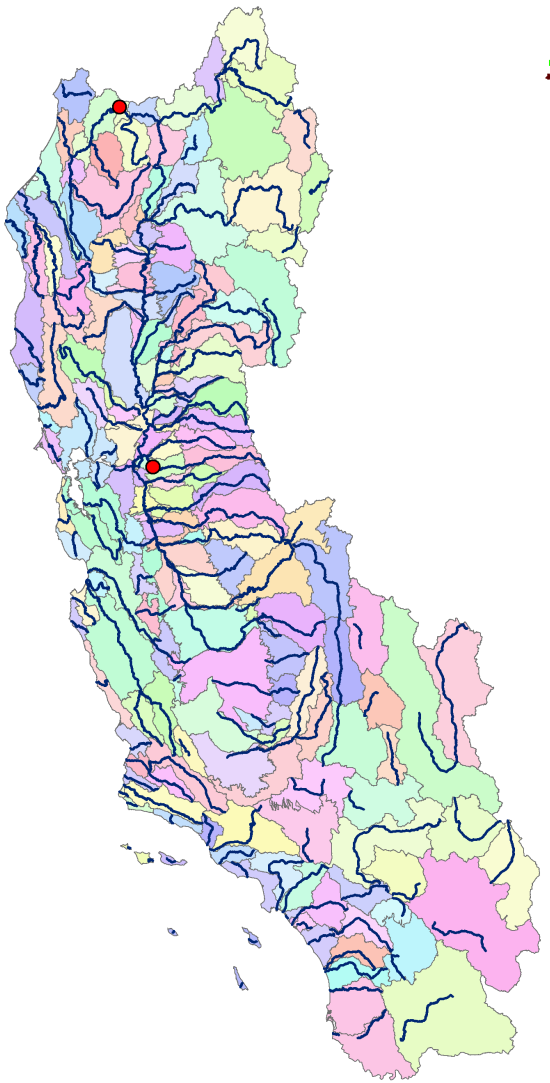


Simulated hydrographs

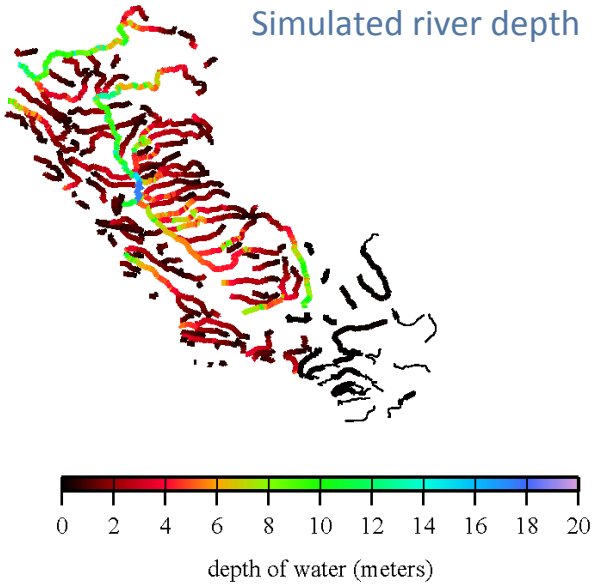


Liu et al, 2013

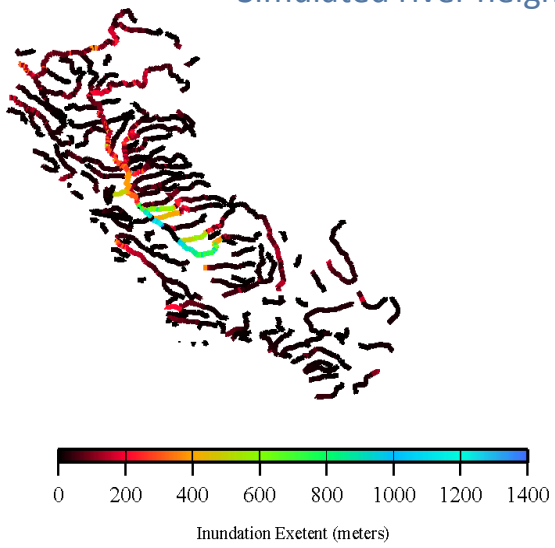
Where we are now: Catchment-based for California



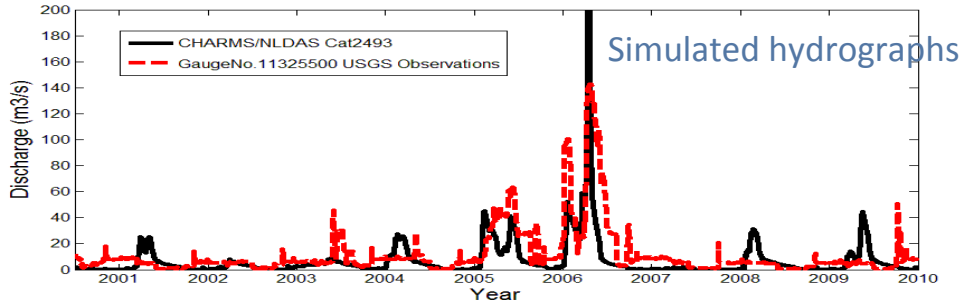
Simulated river depth

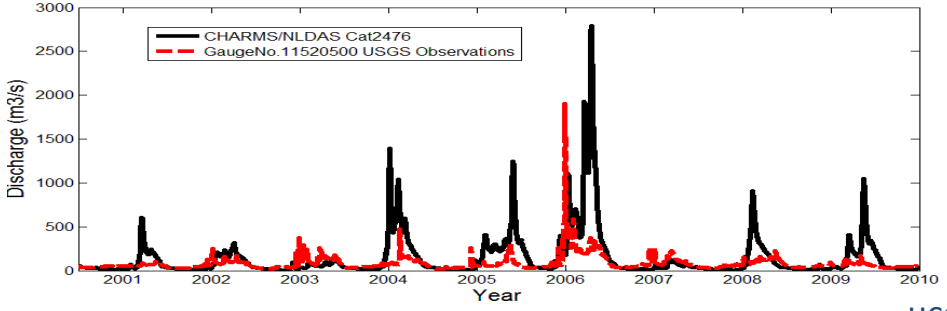


Simulated river height



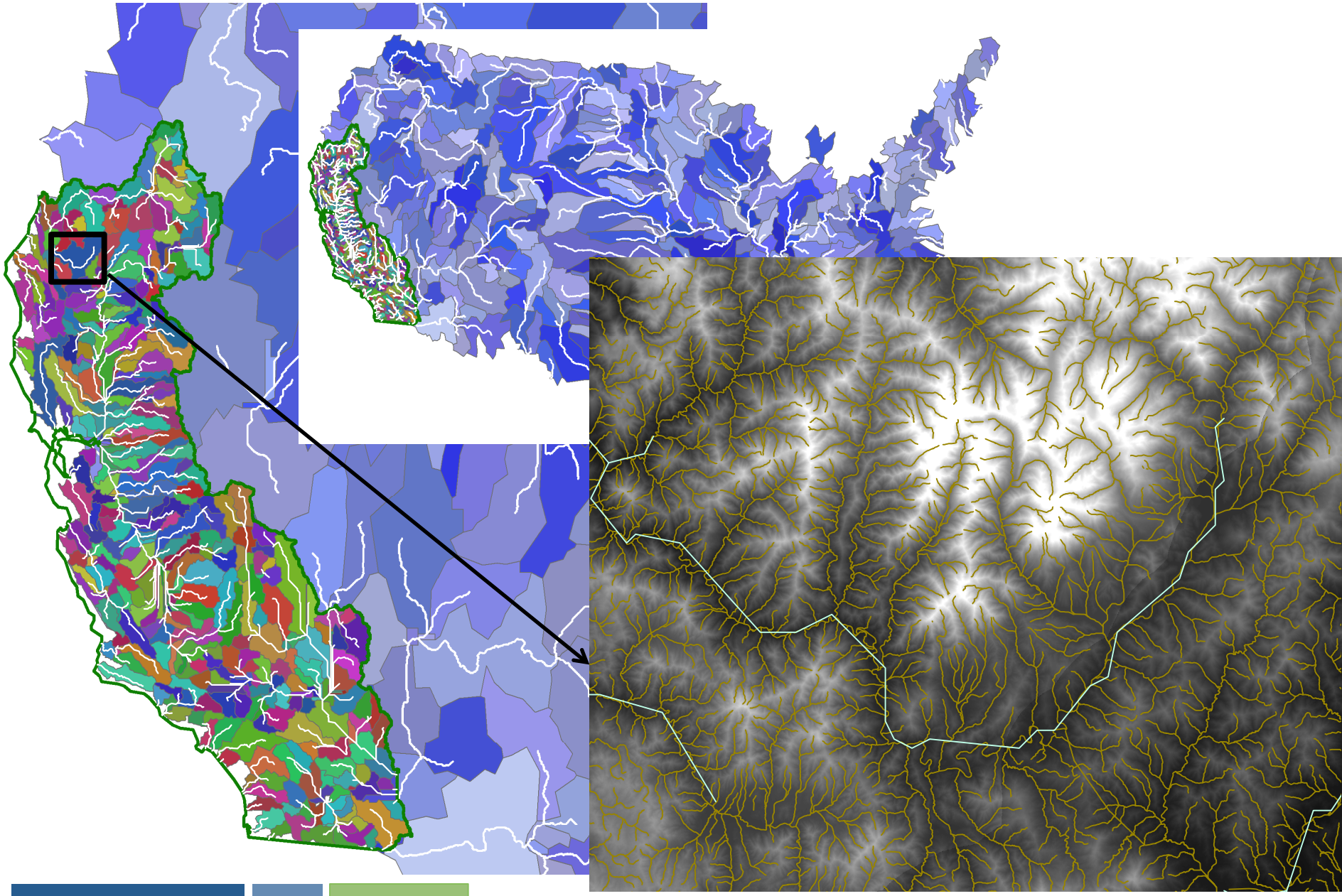
Simulated hydrographs



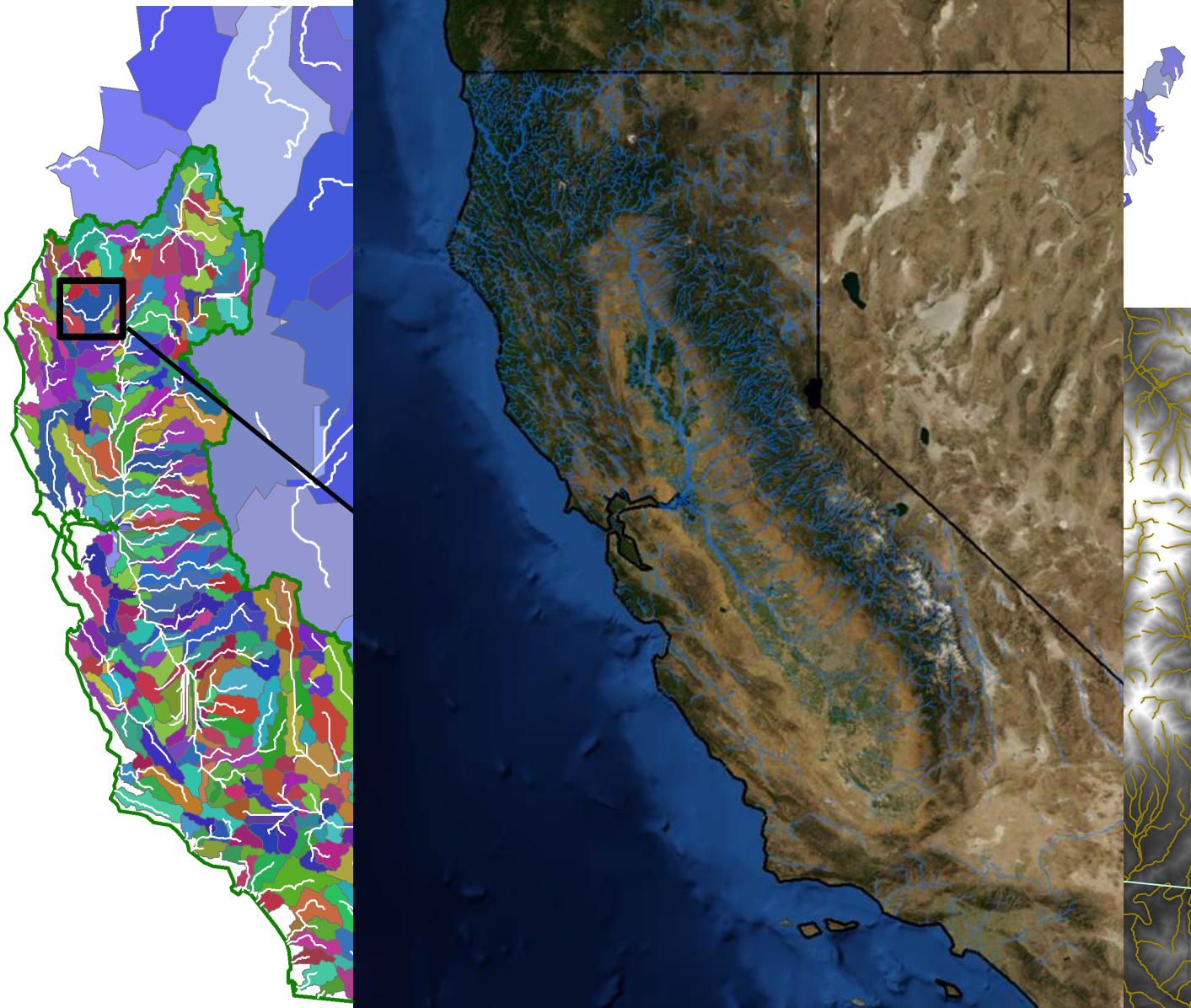


Liu et al, 2013

Where we are going: Multi-scale catchment-based for US/California

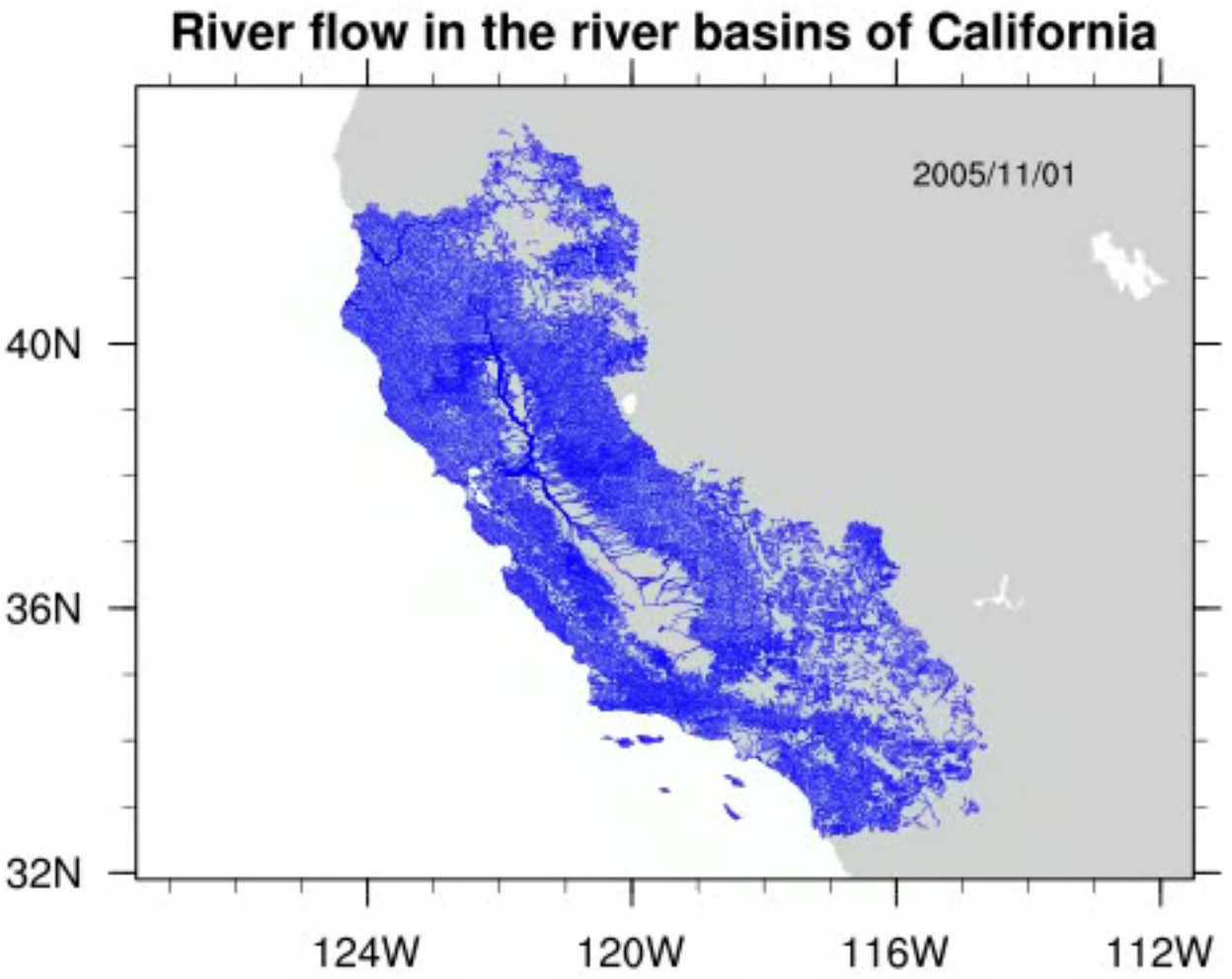


Where we are goi… …rnia



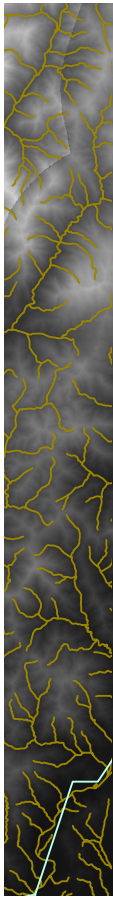
water

Where we are goi[illegible]rnia



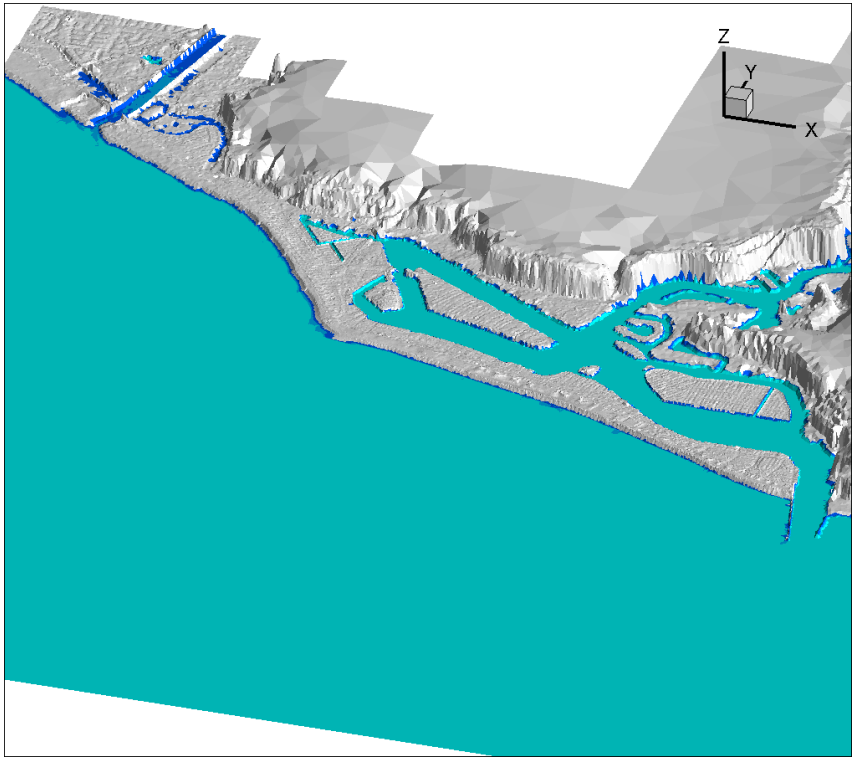
http://www.geo.utexas.edu/scientist/david/rapid.htm

David et al. (201x), in preparation

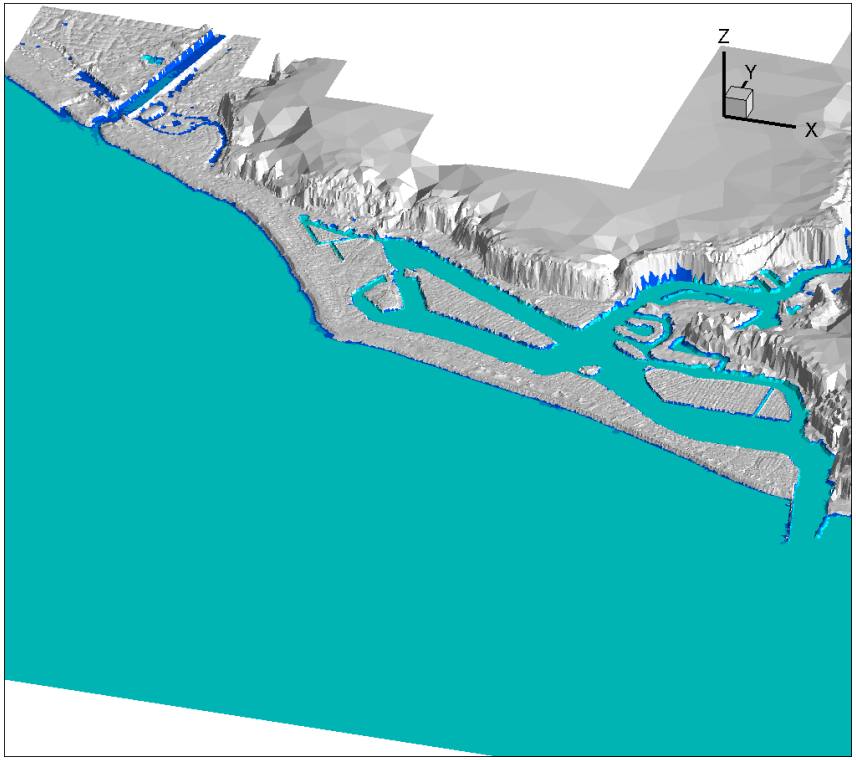


Coastal Flood Modeling, Newport Beach, CA♪

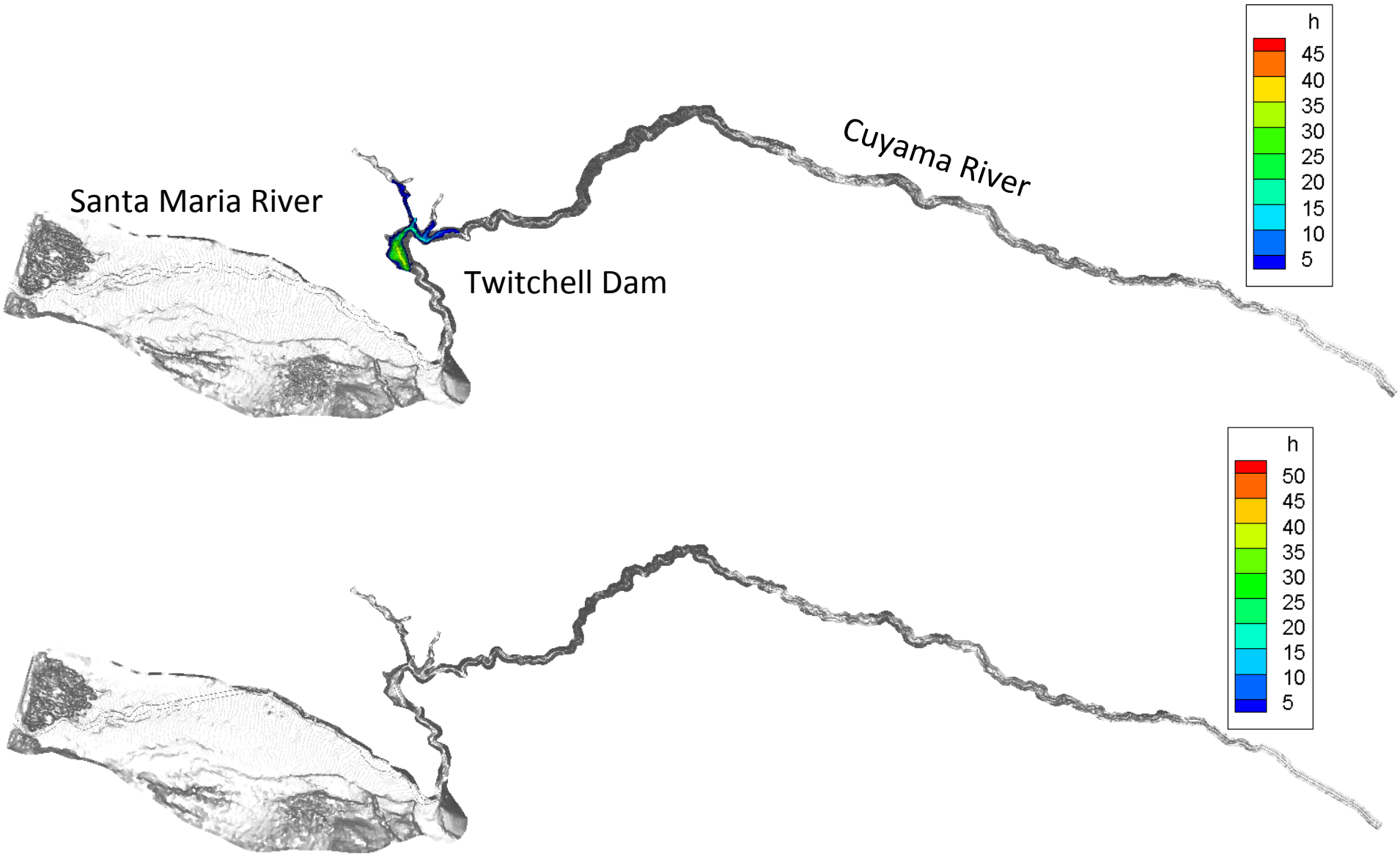
9 ft Storm surge



10 ft Tsunami

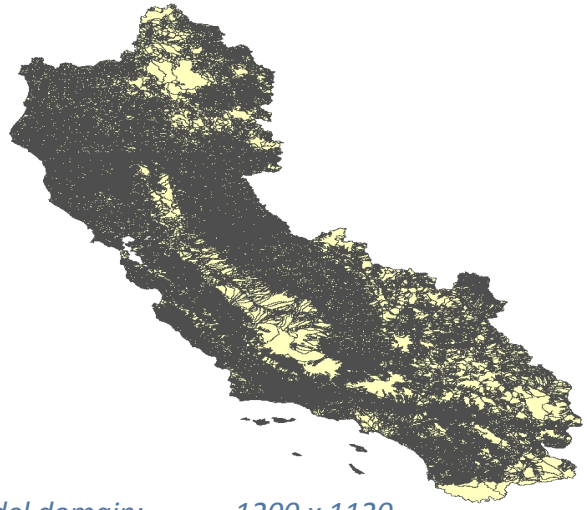


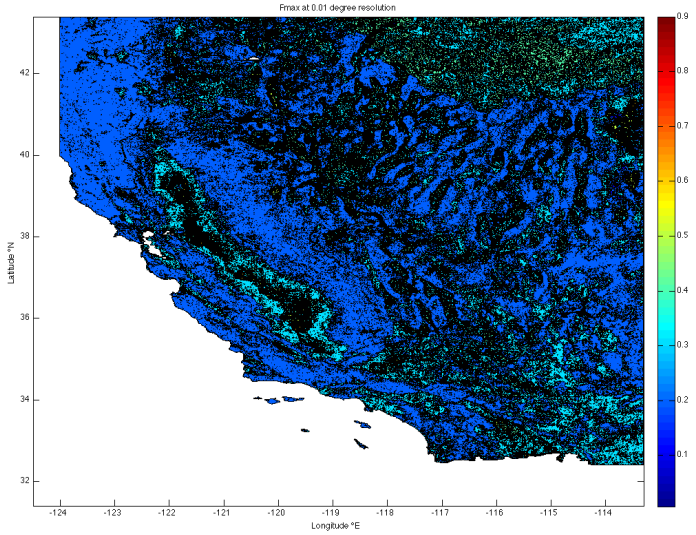
Coupled Hydrologic-Hydraulic Modeling



Where we are now: 1-km CLM over the Western US

High resolution topography to create a 1-km F_{MAX} parameter for each 1-km grid cell in CLM

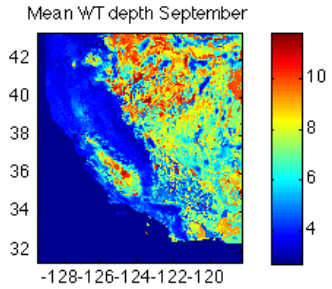


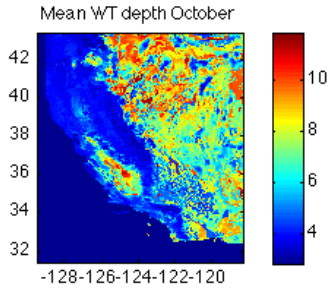


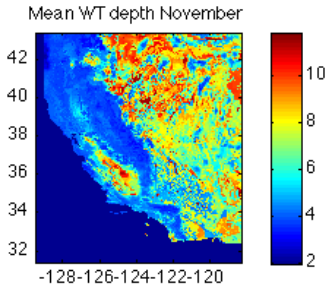
Model domain: *1200 x 1120*

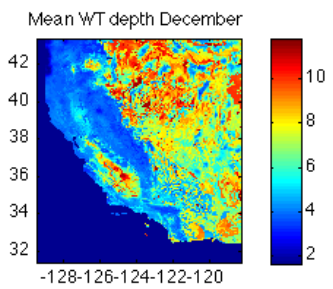
Forcing data: *NLDAS 1/8 degree*

Run time: *6 months/day @ 10 Greenplanet nodes*



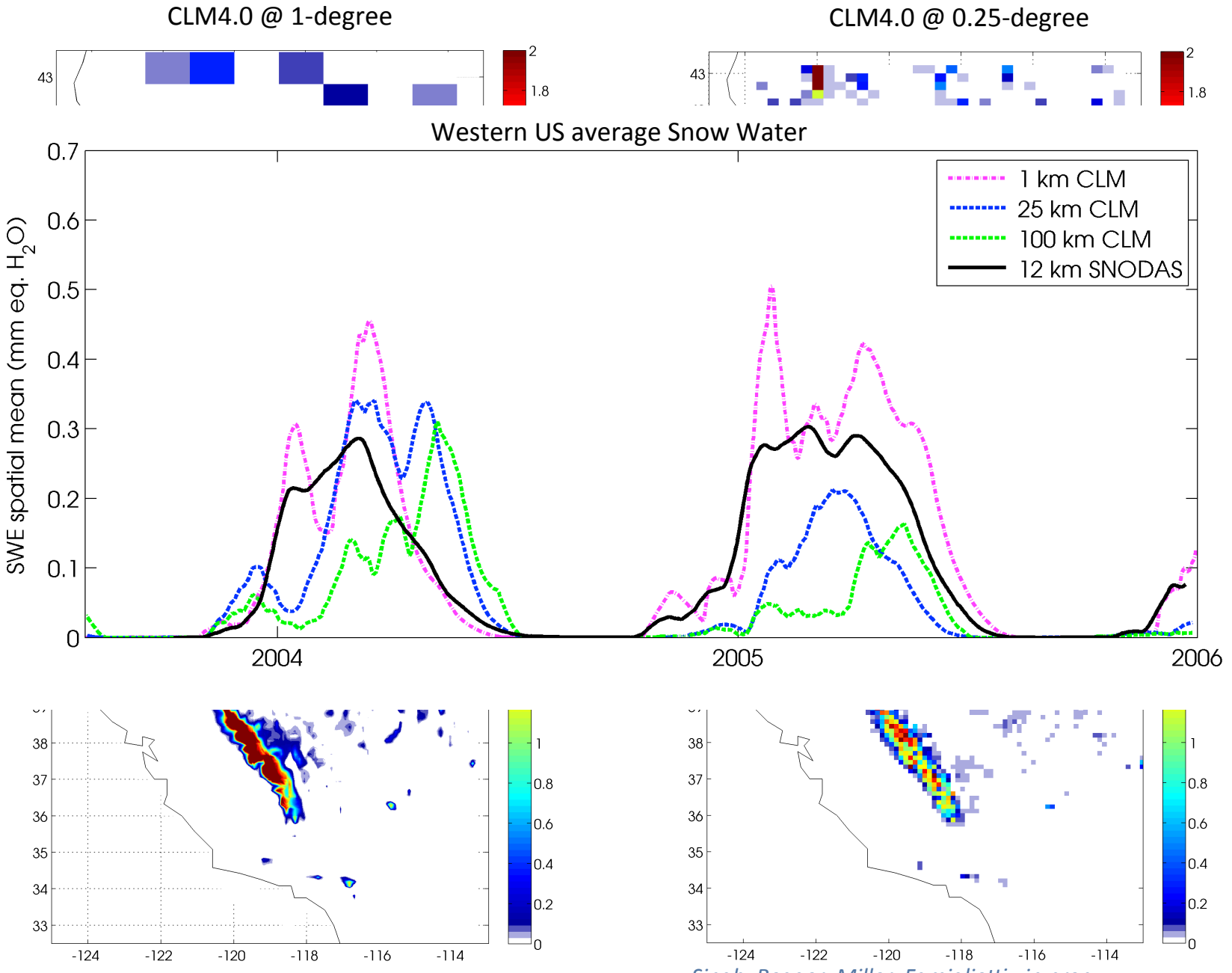






Singh, Reager, Miller, Famiglietti., in prep

Where we are now: 1-km CLM over the Western US

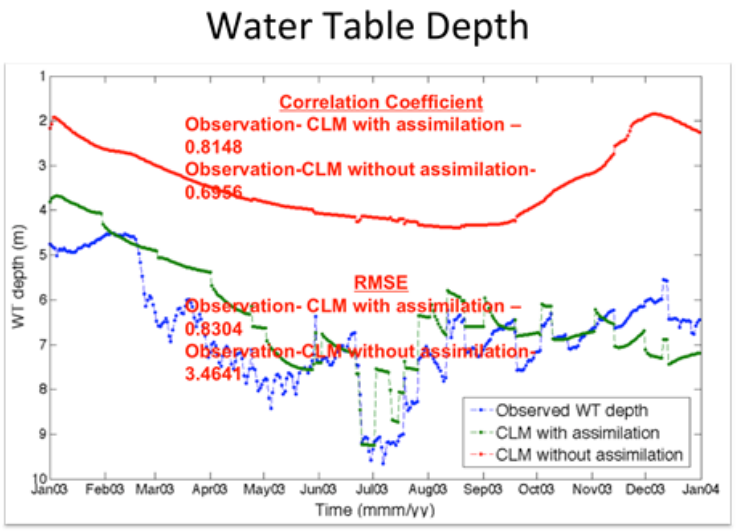


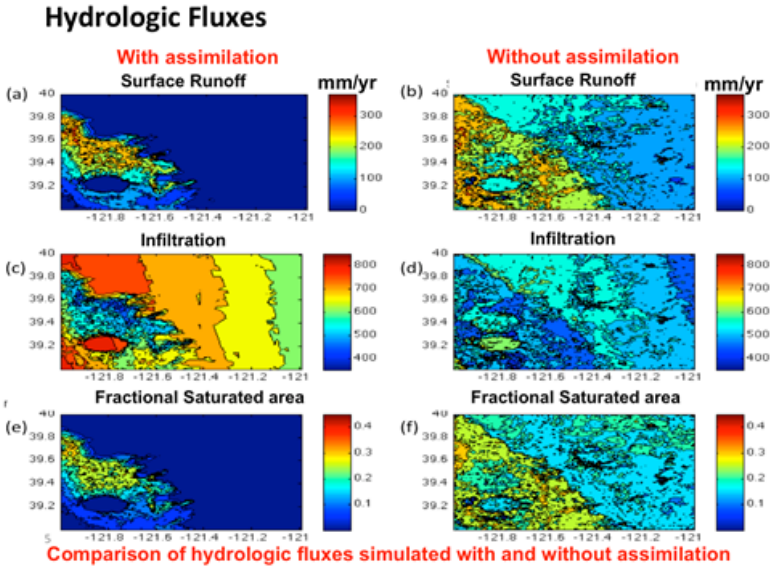
Singh, Reager, Miller, Famiglietti., in prep

rg

Hi-res Southwestern U.S. assim

- Gridded observations obtained using Kriging to overcome sparse groundwater measurement data
- Direct Insertion of groundwater observations successful.
  - No major breakdown of model
  - Improved simulation results
- More advanced assimilation methods using DART failed.
  - Hints at incompatibilities of DART and CLM groundwater formulation

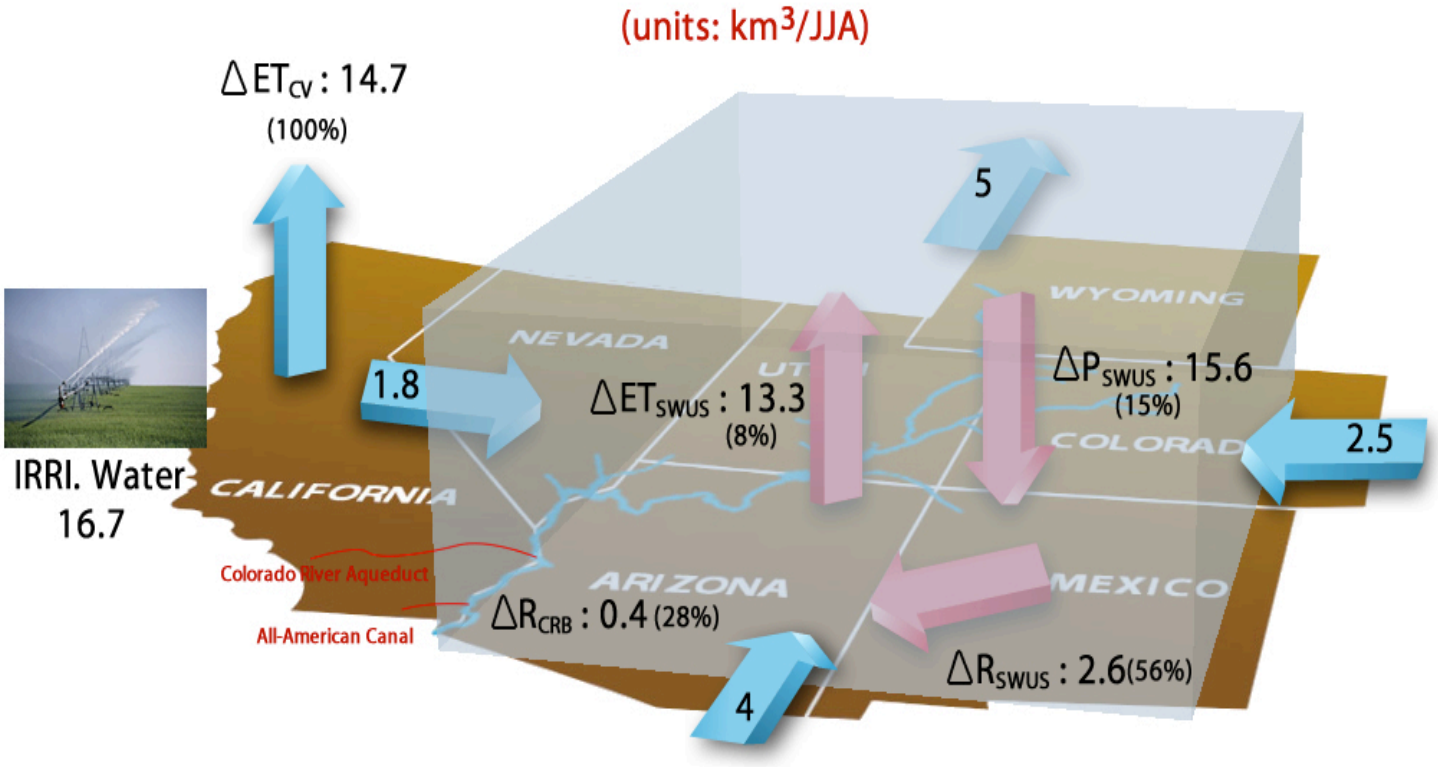




1 km grid, over Southwestern U.S.

Singh, Reager, Miller and Famiglietti (b) (in prep)

Enable new science:
Increased water vapor and rainfall in the southwestern U.S. from irrigation in California



Lo and Famiglietti, 2013

Closing Thoughts

- Groundwater is disappearing in California's Central Valley, in the Coachella Valley and in other localized regions around the state
- GRACE can provide a large area view and raise awareness. Its holistic perspective can also provide early warning on both the flood and drought sides
- GRACE-GPS-InSAR coupled to a groundwater model with deformation component is the next step which could be pursued in a UCI-JPL-DWR WRAP proposal
- Our large-scale models are imporving, but need to be accelerated so that we can answer the questions that need to be answered
- DWR can no longer afford to limit its collaborations in such key areas strictly to agencies. The state and the federal government has invested heavily in universities and the key advances in remote sensing and model development are happening there.
- "We're working with JPL" will no longer suffice and exposes our state to an unneccesarily high level of risk


I PLEDGE TO
SAVE water BY
not takin
a bath
'til
next SUMMER